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A linear perturbation computation method for hydrodynamic stability studies of complex flows: application to an ICF target implosion

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Linear hydrodynamic instabilities in inertial confinement fusion (ICF) target implosions have been previously investigated using linear perturbation codes (*e.g.* Henderson *et al.*, 1974; Dufour *et al.* 1984). In the context of indirect drive implosions, a simple physical model may be retained which corresponds to that of ideal gas dynamics with electronic heat conduction and a laser energy deposition modelling. The resulting systems of equations which are incompletely parabolic, are here written in Lagrangian coordinates for both the spherical symmetric flow and its linear three-dimensional perturbations. Each system is treated using an operator splitting between a hyperbolic reduced system and a parabolic equation. The proposed numerical method significantly differs from previous linear perturbation computation methods, which were based on artificial viscosity schemes (Henderson *et al.*, 1974; Grishina, 1980; Dufour *et al.*, 1984), in that it relies on a finite-volume formulation and explicit Godunov-type schemes (Clarisse *et al.*, 2004) for the hyperbolic reduced systems. The complementary nonlinear/linear parabolic equations are classically handled using semi-implicit iterative/direct methods. Despite the additional difficulties raised by the linear perturbation computations of the symmetric flow discontinuities (*i.e.*, shock-waves), the present numerical method is both reliable and fairly accurate and, above all, is less expensive than 2D-numerical methods by, at least, two orders of magnitude, given the spatially grid coarseness commonly advised for hydrodynamic instability calculations. This feature may be profitably used to obtain detailed descriptions of linear perturbation evolutions during target implosions. Such capabilities will be illustrated by linear perturbation results, obtained with the linear perturbation code *SILEX* , for a *Laser MégaJoule* direct-drive designed ICF target.

References

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